"I intend shortly to send to each possessor of vol. ii. a note of this and of four minor *errata* which have been found in the volume."

(Signed) "ISAAC ROBERTS."

As it is clearly preferable that a correction of this kind should be announced by the author himself, I withdraw my paper, which arrives at substantially the same result. Perhaps I may be permitted to add a word or two of cordial recognition of the way in which Dr. Roberts has throughout spared no pains to establish the truth, whatever it might be. He placed all possible information in my hands for elucidating the matter; and, when I found cause to suspect an error, lost no time in independently examining his results. His re-examination at first conducted him again to his published conclusion; but he was not content until he had checked it in yet another way by new photographs, with the result above quoted.

The Duration of the greater Sun-spot Disturbances for the years 1881–99. By the Rev. A. L. Cortie, S.J.

The number of solar drawings made at Stonyhurst during the last nineteen years amounts to 3,454, or an average of slightly over 180 each year. All the chief disturbances that have occurred during this period have been drawn at some time of their life history. In order to study the possible connection between individual magnetic storms and solar spot outbursts Father Sidgreaves has caused all the chief solar disturbances that have been recorded during these years to be charted, and their life histories to be entered in a ledger. These charts and ledger have been made use of in drawing up the present paper. The charts bear each a rotation number in continuation of Carrington's numbers, and cover the rotations from 364 to 618. Only the larger spot groups, whether single or composite in character, have been selected for entry—such as reached an area of $\frac{1}{1000}$ of the visible solar hemisphere during any part of their life history. A few other groups have been admitted, on account of their being either recurrences of these greater disturbances, or in some way connected with them. The number of such disturbances that have appeared during the 255 solar rotations under discussion amounts to 115. The present paper deals chiefly with the duration of these greater solar disturbances.

In the following table the first column gives the year, and the second the number of the groups according to the Stonyhurst charts. Those numbers which bear an asterisk denote groups that were both born and died in the visible solar hemisphere. Groups which are bracketed are obviously connected as recurrences of the same disturbance. The third and fourth columns

give to the nearest degree the mean heliographic longitude and latitude of a point which was judged by an inspection of the charts to be the centre of the group or groups covering the disturbed area. In compiling these columns our indebtedness to the Greenwich volumes giving the positions of the various groups is very great. The fifth and sixth columns give the dates of the first and last appearance of the disturbance; the seventh column shows the number of times it passed the central meridian of the visible hemisphere, and the eighth its visible duration in days; the last column states the character of the disturbance. If only one group of spots was concerned, even though it might have been of large dimensions and of great extent in area, it is entered as single. If more than one group caused the disturbance the entry is "composite." The line of distinction between these two classes of disturbance was sometimes difficult to draw when a group was very large and extended. Following the table a brief summary, with notes of some of the more obvious deductions to be drawn from an inspection of the charts, is given.

TABLE I.

Year.	Group Number.	Heliographic Long.	Heliographic Lat.	First seen.	Last seen.	Central Times.	Visible Duration, Days.	Character of Disturbance.
		°	°					
1881	1	350	−12	May 30	July 2	2	33	Single
	2	312	+24	July 25	Aug. 4	1	10	,,
	3	289	+16	Oct. 14	Dec. 17	3	64	Composite
	4	226	+13	Nov. 13	23	2	40	,,
1882	5	88	−18	Apr. 10	Apr. 23	1	13	Single
	6	64	−29	12	May 24	2	42	,,
	7	176	+23	May 1	June 9	2	39	,,
	*7a	67	+22	Sept. 2	Oct. 2	2	30	,,
	8	44	−22	24	Dec. 1	3	68	Composite
	9	165	+16	Oct. 13	Nov. 20	2	38	,,
	*10	121	+19	20	Dec. 20	3	61	Single
1883	11	15	+ 8	Feb. 11	Feb. 22	1	11	,,
	*12	73	− 9	June 1	Aug. 19	4	79	,,
	13	36	+11	25	18	3	54	,,
	14	133	−22	Sept. 8	Nov. 14	3	67	,,
	15	127	+11	Oct. 8	12	2	35	,,
	16	36	−12	12	Jan. 13	4	93	Composite
1884	17	27	−10	Mar. 31	July 17	5	108	Single
	18	151	− 8	Apr. 21	14	4	84	,,
	19	224	+16	Aug. 24	Sept. 29	2	36	,,
	20	15	+15	Sept. 6	Dec. 8	4	93	Composite

Year.	Group Number.	Heliographic Long.	Heliographic Lat.	First seen.	Last seen.	Central Times.	Visible Duration, Days.	Character of Disturbance.
1884	21	55°	+8°	Dec. 20	Jan. 1	1	12	Single
1885	22	250	−14	Jan. 30	June 25	6	146	Composite
	23	123	+12	Apr. 3	8	3	66	Single
	24	250	+11	May 18	Aug. 19	4	93	,,
	25	54	−17	June 1	7	3	67	Composite
	26	355	− 5	6	July 15	2	39	Single
	27	168	−13	23	Aug. 25	3	63	Composite
1886	28	34	− 6	Jan. 8	May 31	6	143	,,
	29	71	−10	Mar. 29	Sept. 15	7	170	Single
	30	333	+ 9	May 2	June 28	3	57	,,
	31	302	−14	June 3	Aug. 5	3	63	,,
1887	*32	92	− 8	May 14	Sept. 4	5	113	Composite
	*33	87	− 5	Oct. 2	Oct. 4	1	2	Single
	34	83	− 8	Dec. 14	Jan. 21	1	38	,,
1888	35	274	− 8	May 11	May 23	1	12	,,
	*36	270	− 8	July 6	July 17	1	11	,,
	37	275	− 8	Aug. 8	Aug. 10	1	2	,,
	38	277	− 6	28	Sept. 9	1	12	,,
	39	165	−14	Sept. 6	Dec. 9	3	94	Composite
1889	40	35	− 7	June 16	Aug. 20	3	65	Single
	*41	82	− 8	July 14	Sept. 4	3	52	,,
	*42	156	−22	Aug. 2	Oct. 23	4	82	Composite
1890	43	37	+21	25	2	2	38	Single
	44	28	−23	Oct. 19	Nov. 1	1	13	,,
	*45	309	+20	Nov. 22	Dec. 28	2	36	Composite
1891	46	223	+20	July 6	18	7	165	,,
1892	47	263	−22	Sept. 25, '91	Mar. 5, '93	20	527	,,
	47*a*	271	−20	Nov. 14	Dec. 24	2	40	Single
	47*b*	261	−26	Jan. 18	Mar. 17	3	59	,,
	47*c*	266	−19	May 23	June 5	1	13	,,
	47*d*	270	−20	Jan. 24, '93	Feb. 6, '93	1	13	,,
	48	190	+25	Dec. 19, '91	Jan. 27, '92	2	39	,,
	49	32	+28	Mar. 20	Apr. 2	1	13	,,
	50	83	−14	Apr. 17	May 22	2	35	,,
	51	147	+12	June 10	Sept. 29	5	111	,,
	52	40	−31	13	July 19	2	36	,,
	53	92	+11	July 4	Oct. 5	4	93	,,
	53*a*	94	+11	Oct. 29	Nov. 1	1	3	,,

Year.	Group Number.	Heliographic Long.	Heliographic Lat.	First seen.	Last seen.	Central Times.	Visible Duration, Days.	Character of Disturbance.
		°	°					
1892	54	5	+15	Oct. 2	Oct. 12	1	10	Single
	*55	24	−26	27	Dec. 2	2	36	Composite
	56	142	−24	Nov. 13	Nov. 25	1	12	Single
	57	320	−24	Dec. 24	Jan. 5	1	12	,,
1893	58	15	−13	Jan. 16	27	1	11	,,
	59	108	−11	Feb. 5	Feb. 18	1	13	,,
	60	267	+22	Mar. 19	Apr. 28	2	40	,,
	*61	141	−11	Apr. 27	May 25	2	28	,,
	62	78	−21	29	July 5	3	67	,,
	63	320	−15	June 5	Aug. 11	3	67	Single
	64	291	−19	13	Sept. 9	4	88	,,
	65	299	+14	Aug. 2	Nov. 2	4	92	,,
	66	303	− 8	3	Oct. 5	3	63	,,
	66*a*	104	−16	15	Aug. 27	1	12	Composite
	67	173	− 9	19	Nov. 12	4	85	,,
	68	221	− 8	Sept. 4	Sept. 14	1	10	Single
	69	340	− 7	Oct. 18	Nov. 25	2	38	,,
	70	63	− 6	Nov. 9	20	1	11	,,
	71	324	− 8	16	Feb. 16	4	92	Composite
1894	72	190	−30	Feb. 15	Mar. 1	1	14	Single
	73	33	+21	Mar. 28	Apr. 8	1	11	,,
	*74	152	−13	30	June 16	4	78	,,
	75	356	−27	Apr. 3	May 8	2	35	,,
	*76	290	+17	4	12	2	38	Composite
	*77	180	−18	May 11	Aug. 9	4	90	Single
	78	130	+ 9	June 10	6	3	57	,,
	79	76	−13	14	19	3	66	Composite
	80	182	+12	July 2	Sept. 9	3	69	Single
	81	27	+ 6	Aug. 11	14	2	34	,,
	82	60	−12	Sept. 5	Nov. 4	3	60	Composite
	83	77	+11	Nov. 26	Dec. 6	1	10	Single
	*84	307	−19	Dec. 10	Feb. 5	3	57	,,
1895	85	168	−15	15	Dec. 26	1	11	,,
	86	58	−10	Jan. 21	Apr. 22	4	91	,,
	87	300	+23	Apr. 20	July 16	4	87	,,
	88	24	+10	Aug. 1	Nov. 2	4	93	,,
	89	23	−16	Sept. 26	30	3	65	,,

Year.	Group Number.	Heliographic Long.	Heliographic Lat.	First seen.	Last seen.	Central Times.	Visible Duration, Days.	Character of Disturbance.
1895	*90	326°	+9°	Oct. 28	Nov. 29	2	32	Single
	91	303	−13	Dec. 21	Jan. 29	2	39	,,
1896	92	227	−15	Feb. 2	Mar. 2	2	29	,,
	93	258	+15	18	21	2	32	,,
	94	131	+17	Mar. 25	Apr. 6	1	12	,,
	95	34	+16	Apr. 2	13	1	11	,,
	96	72	−10	May 26	June 4	1	9	,,
	*97	296	−12	Aug. 26	Sept. 30	2	35	,,
	98	66	+12	Sept. 10	Oct. 13	1	33	Composite
	99	72	−16	Nov. 3	Dec. 9	1	36	Single
1897	100	345	− 6	Jan. 3	Apr. 5	4	92	,,
	101	217	+ 5	20	May 16	5	116	Composite
	102	263	−10	Apr. 28	Aug. 27	5	121	,,
	103	72	− 6	Aug. 2	Oct. 7	3	66	Single
	104	32	− 9	12	Sept. 13	2	32	,,
	105	206	+10	Dec. 6	Jan. 15	2	40	,,
1898	106	96	− 8	Jan. 18	Mar. 18	3	59	,,
	107	124	−12	Mar. 6	May 1	3	56	,,
	*108	238	−12	Aug. 11	Nov. 6	4	87	,,
	109	310	+14	Sept. 27	3	2	37	,,
1899	110	219	− 9	Mar. 15	Apr. 12	2	28	,,
	111	330	+ 5	June 24	July 5	1	11	,,
	*112	181	−11	15	Aug. 2	3	48	,,

Summary of the Disturbances.

The rotations of the first half of 1881, those from 364 to 371, were free from greater disturbances, the first charted (Greenwich numbers 485, 500, 503) occurring during May, June, and July. Rotations 373 and 374, covering the months of August, September, and the first half of October, were also without greater spot groups. The three next rotations—375, 376, and 377—were disturbed, and were succeeded by three others—378, 379, and 380—without any great disturbance. Another set of three—381, 382, 383 (1882 March 27·76–June 17·46)—were disturbed, and these again were succeeded by yet another triplet—384, 385, 386 of solar calm. Four more rotations, 387–390, occurred before the end of 1882, and these were all disturbed. Of the five rotations, 391–395, covering the months 1883 January to May 10, only one, 393, had any signs of greater disturbance. But after these preliminary fluctuations a period of fourteen rotations commenced with 396

(1883 May 10·86), and terminated with 411 (1884 July 20·08), which were all more or less disturbed. After a breathing space of one rotation, 412, the disturbances were resumed, covering an interval of five rotations, 413 to 417 (1884 Dec. 31·27). After the lapse of another single rotation the eight rotations 419 to 426 (1885 January 26·11–September 2·13) were all subject to greater disturbances, 424 being especially affected. The four next, 427–430, were free from outbursts (1885 December 20·23). Ten rotations, 431–440, cover the period from this date to 1886 September 18·98, and they were all disturbed. This set is answered by another of eight rotations, 441–448, in a state of quiescence, thus covering the interval to 1887 April 25·47.

The solar surface, therefore, with but two short periods of rest, each extending over one rotation only, was continuously subject to these greater disturbances during the period of time from 1883 May 10·86–1885 September 2·13. After this date the fluctuation was four calm and ten disturbed rotations until 1886 September 18·98. Then ensued a distinct lull in the disturbed state of the Sun. In this connection it may be recalled, as was pointed out in a former paper (*Monthly Notices, R.A.S.* vol. xlvii. No. 1), that bands in the spectra of sun-spots—indicating presumably a cooling in the absorbing materials constituting the spots—began to appear at the commencement of 1885, and disappeared with the almost abrupt dropping of the sun-spot curve in the autumn of 1886.

After a period of rest, rotations 441 to 448, a new series of disturbances, intermittent in character, commenced in 1887 May —rotation 449. Six rotations—449 to 454—saw the life histories of two connected disturbances, two rotations—455, 456—intervened ; and the same disturbance presumably, from its latitude and longitude, broke out again, and remained for yet two more rotations—457, 458. Four rotations of rest then ensued, covering the period 1888 January–May 11, and again a set of four groups broke out in a restricted area, which were presumably due to a common cause ; group 35 occupying the rotation 463, rotation 464 being calm, and groups 36, 37, and 38 occurring in rotations 465, 466, 467 (1888 August 28·15). A new group, 39, appearing in rotation 467, caused the next rotation, 468, to be disturbed ; 469 was then undisturbed, and group 39 again reappears in 470. The intermittent character of the action of the presumed causes of allied disturbances, the presumption resting on the identity of mean position of the several groups of spots, is very remarkable in these disturbances during the period of minimum spot activity. The six rotations 471 (1888 December 15·33) to 476 (1889 April 30·90) were quiet, while the following six, 477 (1889 May 28·12) to 482 (1889 October 11·28), were disturbed. Then came a long calm, extending over the ten rotations 483–492 (1889 November 7·58–1890 August 7·31), which closed the spot cycle. Group 40, the region of which had been disturbed since 1888 July 6, and group 41 were the last large groups of

this cycle. It is worthy of note that all the disturbances, eleven in number, which appeared in the rotations 411 to 492, covering the period of this solar minimum, were observed in the southern hemisphere of the Sun. In rotation 482, just before the long period of calm closing the cycle, appeared group 42 in south latitude 22°, which, as far as these greater disturbances are concerned, heralded the advent of a new cycle. It did not, however, commence with any appearance of continuity until group 43 broke out in north latitude 21°. As the six rotations 471 to 476 of calm were responded to by six other rotations of disturbance in the year 1889, so now again six disturbed, 493–498 (1890 August 7·31–1891 January 18·09), are followed by six undisturbed rotations, numbered 499 to 504 (1891 January 18·09–June 30·71). These alternating equal periods of calm and unrest, noticed before in the sets of rotations in the years 1881 and 1882 before the beginning of the maximum, are at least curious if merely the result of coincidence.

The new series of disturbances which commenced in rotation 505 continued for no less than sixty-seven rotations (1891 June 30·71–1896 July 1·14). This, the second maximum which occurred during the years under discussion, was marked by considerably more disturbances than was the former maximum, the ratio being about 53 to 28. During this maximum also a region of the solar surface comprised between the limits 249° to 281° of longitude and 13° to 27° of south latitude was the seat of continuous disturbance from 1891 September 25 to 1893 March 5, and of intermittent disturbance for months afterwards. Four exceptionally large groups, which were all connected the one with the other, broke out during this time—numbered 47_a, 47_b, 47_c, 47_d in the table—with thirteen other groups of smaller dimensions. Group 47_b, indeed, was the largest group as yet recorded either at Greenwich or Stonyhurst. The duration of this disturbance reached 527 days. A full discussion of this extraordinary outburst is reserved for a future occasion. Another long-continued disturbance was No. 46, which lasted for 165 days. The region of this disturbance, 20° N. latitude, corresponding to 22° S. latitude of group 47, had showed signs of unrest since 1891 April 19. From a study of these and similar outbursts it would seem probable that the force causing the disturbance acts at first in an intermittent and relatively feeble manner, until, gathering ever-increasing strength, it is manifested by an outburst of great dimensions, to be in turn followed until quiescence by yet more intermittent outbreaks. The high latitude of the spot groups in this maximum is worthy of note.

The single groups 63, 64, 65, 66 were all close together, and seemingly were connected. They were also not very far removed from the seat of action of the giant disturbance of this maximum. The composite disturbance 71 appeared in a region which continued to be intermittently disturbed until 1895 January 12. During the last three months of 1893 and the first three of 1894,

in the period covered by rotations 534 to 540, the groups appeared in low latitudes; but in rotation 540 a large group, No. 72, broke out in S. latitude 30°, followed, with the intermission of one group, by two others, 73 and 75, also in high latitudes, thus staying the gradual descent of the groups in latitude with the advance of the cycle. Even in 1896, towards the end of the maximum, the mean latitude of the groups was fairly high, about 16°. There seem to be signs of a subsidiary spot cycle being superposed on the main cycle. Groups 84, 85, 87, 88, 89, occurring when the maximum was well advanced, were all characterised by rapid growth and decline. With regard to other groups of the period, it may be noted that 82 is a possible recurrence of 79, while 85 is a probable recurrence of 77. The connecting link between these last two disturbances is a minor outbreak in the same region in 1894 November. Subsequently, too, the same region was again disturbed, though in a less degree, in 1895 January.

After the disturbances during this long-continued period of unrest had at length subsided, but two rotations of quiet intervened, 572 and 573, when a remakable continuous stream of most irregular spots, extending at least 25° in longitude, appeared during the two following rotations, 574 and 575. No sooner had it vanished than its counterpart appeared, also during two rotations, 576, 577, S. of the equator, of almost equal length, of similar character, and in approximately the corresponding longitude and latitude. Moreover, both these streams of spots were almost exactly parallel to each other, and inclined at the same angle of about 15° to the equator. This is a remarkable, but by no means a solitary, instance of correlated and answering disturbances in the same position N. and S. of the equator. The subject needs more rigorous investigation, though even a glance through the charts indicates the existence of the phenomenon. Among such groups 83 seems to answer 82, 89 responds to 88, and 93 has its counterpart in 92.

After the disappearance of these groups the solar surface continued to be disturbed through eleven rotations, 578 to 588, followed by a period of rest during two rotations, thus bringing the record down to the end of 1897. It must be noted, however, that during these rotations there was quite a sudden fall in the latitude of the five groups, 100 to 104, covering them, the drop in latitude being accompanied by a simultaneous increase in duration. The region of group 101 continued to be disturbed until November 21 by small and short-lived groups. The great decline in the mean distance of these spots from the equator has already been called attention to by the Astronomer Royal in *Monthly Notices*, vol. lix. 1. After the outburst, No. 104, the Sun was almost spotless for two rotations, 589 and 590. The next three groups in order of numbering extended over five rotations, 591 to 596 (1897 December 1·32–1898 May 14·18). For the three next rotations, 597 to 599, extending through the months 1898

May to August, the Sun was again almost entirely devoid of spots. The group 108 appeared at first small in area in rotation 600, and together with group 109 caused this and the two following rotations to be disturbed. Rotation 604 (1898 November 20·89) was the commencement of another quiet series of rotations, which lasted until the end of 607 (1899 March 10·21). The two next rotations, 608, 609, saw the life history of group 110; rotation 610 was calm; 611 to 613 were affected by groups 111 and 112; and the remaining six rotations of the years under review, 614 to 618 (1899 August 20·61–1900 January 4·09), maintained an undisturbed appearance.

In the yearly summaries of the Greenwich results for sun-spot area and position, which are published in the *Monthly Notices*, it has been noticed that the preponderance of all the sun-spots has for several years belonged to the southern hemisphere of the Sun. The same is true for the greater disturbances tabulated in this paper. Up to the end of 1886 such outbursts were equally distributed between the two hemispheres, 16 to each; but since a minimum period set in, in the year 1887, the southern hemisphere has maintained a decided supremacy until the termination of the next minimum, the numbers being 55 in the southern against 28 in the northern hemisphere.

With regard to the duration of the several groups, assuming Carrington's value of 25·38 days as the period of a solar rotation, the 115 groups are distributed as follows :—

Between rotations.	Number of groups.	Percentage.
0 to 1	28	24·3
1 to 2	34	29·6
2 to 3	24	20·9
3 to 4	19	16·5
4 to 5	5	4·3
5 to 6	2	1·7
6 to 7	2	1·7

One abnormal disturbance of 20·7 rotations is omitted.

Hence it appears that the greater number of disturbances, nearly 30 per cent., live through a period between 1 and 2 rotations.

This conclusion is borne out if the whole number of days of disturbance be divided by the total number of disturbances. From this we get that the average life of a disturbance is 56·0 days, or a little more than two rotations. If we take those groups only which were born and also died on the Sun's visible hemisphere, numbering 19 in all, and get a mean in this manner, the result is that the average life of a solar disturbance is 52·4 days, or again slightly more than two solar rotations.

The average duration, then, of a sun-spot disturbance—for we have neglected altogether the disturbances manifested by

means of faculæ—appears to be of the period of two solar rotations.

Besides this conclusion, which was the chief object for which the above table was prepared, the following points for more detailed investigation and study are suggested by the summary review of the disturbances during the last nineteen years :—

(1) In the alternations of quiet and disturbed periods, seven of twenty-two are of equal duration reckoned in rotations of the Sun. Is this equality of alternating periods merely a coincidence ?

(2) The action of the foci of disturbance differs in the maximum and in the minimum periods of sun-spots. In the former it is at some time continuous, in the latter always intermittent.

(3) In a set of allied disturbances the mode of action of the force causing them is at first intermittent, then culminates in a grand outburst, and dies away in another set of intermittent disturbances.

(4) The superposition of minor subsidiary cycles of disturbance upon the main cycle of eleven years seems to be apparent.

(5) Groups towards the end of the period of maximum seem to grow and decline very rapidly.

(6) There seems to be no doubt that allied disturbances occur in identical positions north and south of the equator of similar character and extent.

(7) The noteworthy concentration of disturbances in the southern hemisphere of the Sun during the last maximum and the preceding minimum suggests an answering concentration of disturbances in the northern hemisphere in the coming maximum.

Stonyhurst College Observatory:
1900 *May* 5.

Note on Measures by Professor Barnard of two Standard Points on the Moon's Surface. By S. A. Saunder, M.A.

In a paper communicated to the Society last January (*ante*, p. 174) attention was called to the increase of accuracy in selenographic positions which might be attained by measuring from a well-determined point instead of from the limb, and to the suitability of Mösting A as an origin. It was my good fortune that Professor Barnard was present at the meeting at which the paper was read, and the next day he most kindly offered to measure a few points on the Moon itself if the results would be of any assistance to me. This generous offer I gladly accepted, and I have now received from him the particulars of measures made on April 7 and 9, with the full aperture of the 40-inch telescope of the Yerkes Observatory, and a magnifying power of